

IN THE CLAIMS

1 1. (UNCHANGED) A method for reducing a precision of an
2 input datum having precision portion and a loss portion,
3 comprising:

4 a. comparing the loss portion to a preselected
5 threshold value, f_t ;

6 b. determining a selectable bias, α , responsive to the
7 loss portion being in a defined relation to the preselected
8 threshold value, f_t ; and

9 c. combining the precision portion with α , creating a
10 reduced precision datum thereby,

11 wherein α corresponds to a predetermined characteristic of one
12 of α , the input datum, the reduced precision datum, and a
13 combination thereof.

1 2. (UNCHANGED) The method of claim 1, wherein determining
2 the selectable bias further comprises one of:

4 a. assigning a first value to α , responsive to the loss
portion being substantially equal to f_t ;

5 b. assigning a second value to α , responsive to the
6 loss portion being less than f_t ; and

7 c. assigning a third value to α , responsive to the loss
8 portion being greater than f_t .

1 3. (UNCHANGED) The method of claim 1, further comprising
2 determining the selectable bias responsive to a predetermined
3 characteristic of a plurality of input data relative to a
4 corresponding plurality of reduced precision data.

1 4. (UNCHANGED) The method of claim 1, further comprising
2 determining the selectable bias responsive to a predetermined
3 characteristic attributable to reducing the precision of the input
4 datum.

1 5. (UNCHANGED) The method of claim 1, further comprising
2 determining the selectable bias responsive to the predetermined
3 characteristic of the selectable bias, the predetermined
4 characteristic being the mean value of a plurality of selectable
5 bias values.

1 6. (UNCHANGED) The method of claim 2, further comprising
2 determining the selectable bias responsive to a predetermined
3 characteristic of a plurality of input data relative to a
4 corresponding plurality of reduced precision data, and the
5 predetermined characteristic being attributable to reducing the
precision.

1 7. (UNCHANGED) The method of claim 6, wherein the
2 predetermined characteristic is a predetermined mean error value.

1 8. (UNCHANGED) The method of claim 2, further comprising
2 determining the selectable bias responsive to a predetermined
3 characteristic of one of input data, a corresponding reduced
4 precision data, and a combination thereof.

1 9. (UNCHANGED) The method of claim 8, wherein the
2 predetermined characteristic comprises a predetermined statistical
3 value.

1 10. (UNCHANGED) The method of claim 4, wherein the
2 predetermined characteristic comprises a predetermined mean error
3 value of the plurality of reduced precision data relative to a
4 corresponding plurality of input data.

1 11. (UNCHANGED) The method of claim 9, wherein the
2 predetermined statistical value comprises the mean value of the
3 reduced precision data relative to a corresponding plurality of
4 finite-precision fixed point input data.

1 12. (AMENDED) The method of claim 2, further comprising
2 assigning a fourth value to α , responsive to [a] the loss portion
3 being substantially equal to f_t , the fourth value being in a
4 predefined relationship with the first value.

1 13. (UNCHANGED) The method of claim 12, further comprising
2 determining the selectable bias responsive to a predetermined
3 characteristic of input data relative to corresponding reduced
4 precision data, and the predetermined characteristic being a
5 preselected mean error value associated therewith.

1 14. (AMENDED) The method of claim 12, wherein:

- 2 a. the f_t is approximately equal to 0.5_{10} ;
- 3 b. the first value is "1" when the value of the loss
4 portion substantially equals about 0.5_{10} , the input datum is a
5 negative-valued datum, with the first value being added to the
6 precision portion;
- 7 c. the second value is [zero] "0" when value of the
8 loss portion is less than about 0.5_{10} ;
- 9 d. the third value is "1" when the value of the loss
10 portion is greater than about 0.5_{10} , with the third value being
11 added to the precision portion;

12 e. the fourth value is "0" when the loss portion
13 substantially equals about 0.5_{10} , and the input datum is a
14 positive-valued datum; and

15 f. the preselected mean error value relative to the
16 input datum and the reduced precision datum is minimized.

1 15. (AMENDED) The method of claim 11, wherein:

2 a. f_t is substantially equal to 0.5_{10} ;

3 b. the first value is a current first value being
4 selected to be one of ['1']"1" and ['0']"0" when the value of the
5 loss portion substantially equals about 0.5_{10} , in a predefined
6 relationship to a previous first value;

7 c. the second value is [zero] "0" when the loss portion
8 is less than about 0.5_{10} ; and

9 d. the third value is "1" when the loss portion is
10 greater than about 0.5_{10} , with the third value is added to the value
11 of the precision portion.

1 16. (UNCHANGED) The method of claim 14, wherein the
2 predefined relationship is an alternating relationship.

1 17. (AMENDED) The method of claim 16, wherein the alternating
2 relationship is a toggle relationship with the current first value
3 being [zero] "0" if the previous first value was "1", and the
4 current first value being "1" if the previous first value was
5 [zero] "0", and wherein the preselected mean error value is
6 minimized responsive to the alternating relationship.

1 18. (AMENDED) The method of claim 15, wherein the alternating
2 relationship includes a selectable number of "1's" being
3 interleaved with a selectable number of [zeros] "0's", the mean
4 value of the reduced precision data being responsive to the
5 alternating relationship.

1 19. (UNCHANGED) The method of claim 2, wherein each of the
2 input datum and the reduced precision datum are represented by
3 two's complement fixed point values.

1 20. (UNCHANGED) The method of claim 16, wherein the
2 alternating relationship includes a selected pseudorandom sequence
3 of data bits.

1 21. (AMENDED) A method for rounding a first datum, X , having
2 precision of a digits, to a second datum, \hat{X} , having precision of b
3 digits, wherein $a > b$, first b digits of X being a precision
4 portion, and remaining $a-b$ digits of X being a loss portion, the
5 method comprising:

6 a. evaluating the loss portion relative to a
7 preselected rounding threshold value;

8 b. if the loss portion is substantially equal to the
9 preselected threshold, then defining \hat{X} substantially according to
10 the equation:

$$\hat{X} = X + 2^{-(b+1)}\alpha,$$

11 where α is a selectable bias represented by a rounding
12 digit;

13 c. if the loss portion is not substantially equal to
14 the preselected threshold, then defining \hat{X} substantially according
15 to the equation:

$$\hat{X} = X + 2^{-(b+1)}; \text{ and}$$

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cancel.*
18 d. eliminating the loss portion of \mathbf{x} , producing $\hat{\mathbf{x}}$
19 thereby.

1 22. (UNCHANGED) The method of claim 21, wherein selectable
2 bias α is representative of a predetermined characteristic of one
3 of \mathbf{x} , $\hat{\mathbf{x}}$, α , and a combination thereof.

1 23. (UNCHANGED) The method of claim 22, wherein the
2 preselected threshold is substantially equivalent to 0.5_{10} .
3

4 24. (UNCHANGED) The method of claim 23, wherein the
5 predetermined characteristic comprises a preselected mean error
6 value of $\hat{\mathbf{x}}$ relative to \mathbf{x} .

1 25. (UNCHANGED) The method of claim 24, wherein the
2 preselected mean error value, $E(e)$, is substantially defined by the
3 equation:

$$E(e) = 2^{-a}(E(\alpha) - \frac{1}{2}),$$

6 where $E(\alpha)$ is a mean value of selectable bias α .

7 26. (UNCHANGED) The method of claim 25 wherein the mean
8 value of the selectable bias is substantially within the range of
9

$$0.0 \leq E(\alpha) < 1.0$$

1 27. (UNCHANGED) The method of claim 26, wherein the mean
2 value of the selectable bias, $E(\alpha)$, is approximately equal to
3 preselected mean error value, $E(e)$, and $E(\alpha)$ is approximately zero.

1 28. (UNCHANGED) The method of claim 27, wherein the
2 predetermined characteristic further comprises a preselected error
3 variance value, σ_e^2 , substantially defined by the equation:

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$$\sigma_e^2 = \frac{2^{-2b} + 2^{-(2a-1)}}{12}$$

1 29. (UNCHANGED) The method of claim 28, wherein the rounding
2 digit is selected from a alternating sequence of digits in the pair
3 of digits <0,1>.

1 30. (UNCHANGED) The method of claim 28, wherein the rounding
2 digit is selected from a pseudorandom sequence of binary digits.

1 31. (AMENDED) A method for rounding a first two's complement
2 fixed point datum, x , having an integer part of n bits, a
3 fractional part of a bits the integer part, and sign bit, s_i , to
4 a second two's complement fixed point datum, \hat{x} , having a fractional
5 part of b bits following the radix point, where a and b are
6 representative of the respective precisions of x and \hat{x} , and where
7 $a > b$, comprising:

8 a. evaluating the fractional part of x and defining y
9 as the most significant bit (MSB) of the a bits;

10 b. if the first bit following the radix point of x is
11 equal to a "1" bit trailed by $(a-1)$ [zero] "0" bits, then defining
12 \hat{x} substantially according to the equation:

$$\hat{x} = n + s_i$$

14 and

15 otherwise, defining \hat{x} substantially according to the
16 equation:

$$\hat{x} = n + y$$

18 32. (UNCHANGED) The method of claim 31, wherein the
19 occurrence of positive numbers and negative numbers in a plurality
20 of the datum, X, is substantially equiprobable.

1 33. (UNCHANGED) A method for rounding signal values,
2 comprising:

- 3 a. detecting a predetermined state value wherein
4 rounding is desired; and
- 5 b. rounding the state value according to one of
6 i. an alternating round-up/round-down method and
7 ii. a sign addition round-up/round-down method.

1 34. (UNCHANGED) An arithmetic device, comprising a bias
2 generator producing a selectable bias α , responsive to a
3 predetermined signal characteristic, the device receiving an input
4 signal and coupling the selectable bias α thereto.

1 35. (UNCHANGED) The arithmetic device of claim 34, further
2 comprising a combiner coupled to the bias generator, the combiner
3 receiving and combining the input signal and the selectable bias α ,
4 and producing an output signal.

1 36. (UNCHANGED) The arithmetic device of claim 34 further
2 comprising wherein the bias generator further comprises a
3 comparator for comparing the input signal to a preselected
4 threshold value, the comparator urging the bias generator to
5 produce the selectable bias α responsive to the preselected
6 threshold value.

1 37. (NEW) A computer program product recorded on a computer
2 readable medium for reducing a precision of an input datum having
3 a precision portion and a loss portion, comprising:

4 a. computer readable program code which compares the
5 loss portion to a preselected threshold value, f_t ;

6 b. computer readable program code which determines a
7 selectable bias, α , responsive to the loss portion being in a
8 defined relation to the preselected threshold value, f_t ; and

9 c. computer readable program code which combines the
10 precision portion with α , creating a reduced precision datum
11 thereby,

12 wherein α corresponds to a predetermined characteristic of one
13 of α , the input datum, the reduced precision datum, and a
14 combination thereof.

1 38. (NEW) The computer program product of Claim 37, wherein
2 the computer readable program code which determines the selectable
3 bias, further comprises one of:

4 a. computer readable program code which assigns a first
5 value to α , responsive to the loss portion being substantially
6 equal to f_t ;

7 b. computer readable program code which assigns a
8 second value to α , responsive to the loss portion being less than
9 f_t ; and

10 c. computer readable program code which assigns a third
11 value to α , responsive to the loss portion being greater than f_t .

1 39. (NEW) The computer program product of Claim 37, further
2 comprising computer readable program code which determines the
3 selectable bias responsive to a predetermined characteristic of a
4 plurality of input data relative to a corresponding plurality of
5 reduced precision data.

1 40. (NEW) The computer program product of Claim 37, further
2 comprising computer readable program code which determines the
3 selectable bias responsive to a predetermined characteristic
4 attributable to reducing the precision of the input datum.

1 41. (NEW) The computer program product of Claim 37, further
2 comprising computer readable program code which determines the
3 selectable bias responsive to the predetermined characteristic of
4 the selectable bias, the predetermined characteristic being the
5 mean value of a plurality of selectable bias values.

1 42. (NEW) The computer program product of Claim 38, further
2 comprising computer readable program code which determines the
3 selectable bias responsive to a predetermined characteristic of a
4 plurality of input data relative to a corresponding plurality of
5 reduced precision data, and the predetermined characteristic being
6 attributable to reducing the precision.

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1 43. (NEW) The computer program product of Claim 42, wherein
2 the predetermined characteristic is a predetermined mean error
3 value.

1 44. (NEW) The computer program product of Claim 38, further
2 comprising computer readable program code which determines the
3 selectable bias responsive to a predetermined characteristic of one
4 of input data, a corresponding reduced precision data, and a
5 combination thereof.

1 45. (NEW) The computer program product of Claim 44, wherein
2 the predetermined characteristic comprises a predetermined
3 statistical value.

1 46. (NEW) The computer program product of Claim 40, wherein
2 the predetermined characteristic comprises a predetermined mean
3 error value of the plurality of reduced precision data relative to
4 a corresponding plurality of input data.

1 47. (NEW) The computer program product of Claim 45, wherein
2 the predetermined statistical value comprises the mean value of the
3 reduced precision data relative to a corresponding plurality of
4 finite-precision fixed point input data.

1 48. (NEW) The computer program product of Claim 38, further
2 comprising computer readable program code which assigns a fourth
3 value to α , responsive to the loss portion being substantially
4 equal to f_t , the fourth value being in a predefined relationship
5 with the first value.
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1 49. (NEW) The computer program product of Claim 48, further
2 comprising computer readable program code which determines the
3 selectable bias responsive to a predetermined characteristic of
4 input data relative to corresponding reduced precision data, and
5 the predetermined characteristic being a preselected mean error
6 value associated therewith.
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1 50. (NEW) The computer program product of Claim 48, wherein:
2 a. the f_t is approximately equal to 0.5_{10} ;
3 b. the first value is "1" when the value of the loss
4 portion substantially equals about 0.5_{10} , the input datum is a
5 negative-valued datum, with the first value being added to the
6 precision portion;
7 c. the second value is "0" when value of the loss
8 portion is less than about 0.5_{10} ;

9 d. the third value is "1" when the value of the loss portion
10 is greater than about 0.5_{10} , with the third value being added to the
11 precision portion;

12 e. the fourth value is "0" when the loss portion
13 substantially equals about 0.5_{10} , and the input datum is a
14 positive-valued datum; and

15 f. the preselected mean error value relative to the input
16 datum and the reduced precision datum is minimized.

1 51. (NEW) The computer program product of Claim 47, wherein:

2 a. f_t is substantially equal to 0.5_{10} ;

3 b. the first value is a current first value being
4 selected to be one of "1" and "0" when the value of the loss
5 portion substantially equals about 0.5_{10} , in a predefined
6 relationship to a previous first value;

7 c. the second value is "0" when the loss portion is
8 less than about 0.5_{10} ; and

9 d. the third value is "1" when the loss portion is
10 greater than about 0.5_{10} , with the third value is added to the value
11 of the precision portion.

1 52. (NEW) The computer program product of Claim 50, wherein
2 the predefined relationship is an alternating relationship.

1 53. (NEW) The computer program product of Claim 52, wherein
2 the alternating relationship is a toggle relationship with the
3 current first value being "0" if the previous first value was "1",
4 and the current first value being "1" if the previous first value
5 was "0", and wherein the preselected mean error value is minimized
6 responsive to the alternating relationship.

1 54. (NEW) The computer program product of Claim 57, wherein
2 the alternating relationship includes a selectable number of "1's"
3 being interleaved with a selectable number of "0's", the mean value
4 of the reduced precision data being responsive to the alternating
5 relationship.

1 55. (NEW) The computer program product of Claim 38, wherein
2 each of the input datum and the reduced precision datum are
3 represented by two's complement fixed point values.

1 56. (NEW) The computer program product of Claim 52, wherein
2 the alternating relationship includes a selected pseudorandom
3 sequence of data bits.

1 57. (NEW) A computer program product recorded on a computer
2 readable medium for rounding a first datum, x , having precision of
3 a digits, to a second datum, \hat{x} , having precision of b digits,
4 wherein $a > b$, first b digits of x being a precision portion, and
5 remaining $a-b$ digits of x being a loss portion, comprising:
6 a. computer readable program code which evaluates the
7 loss portion relative to a preselected rounding threshold value;
8 b. computer readable program code which, if the loss
9 portion is substantially equal to the preselected threshold, then
10 defines \hat{x} according to the equation:

$$\hat{x} = x + 2^{-(b+1)}\alpha,$$

11 where α is a selectable bias represented by a rounding
12 digit;

13 c. computer readable program code which, if the loss
14 portion is not substantially equal to the preselected threshold,
15 then defines \hat{x} according to the equation:

16 $\hat{x} = x + 2^{-(b+1)}$; and

18 d. computer readable program code which eliminates the
19 loss portion of \mathbf{X} , producing $\mathbf{\hat{X}}$ thereby.

1 58. (NEW) The computer program product of Claim 21, wherein
2 selectable bias α is representative of a predetermined
3 characteristic of one of \mathbf{X} , $\mathbf{\hat{X}}$, α , and a combination thereof.

1 59. (NEW) The computer program product of Claim 58, wherein
2 the preselected threshold is substantially equivalent to 0.5_{10} .

1 60. (NEW) The computer program product of Claim 59, wherein
2 the predetermined characteristic comprises a preselected mean error
3 value of $\mathbf{\hat{X}}$ relative to \mathbf{X} .

1 61. (NEW) The computer program product of Claim 60, wherein
2 the preselected mean error value, $E(\epsilon)$, is substantially defined by
3 the equation:

$$E(\epsilon) = 2^{-\alpha} (E(\alpha) - \frac{1}{2}),$$

4 where $E(\alpha)$ is a mean value of selectable bias α .

1 62. (NEW) The computer program product of Claim 61, wherein
2 the mean value of the selectable bias is substantially within the
3 range of:

$$0.0 \leq E(\alpha) < 1.0$$

1 63. (NEW) The computer program product of Claim 62, wherein
2 the mean value of the selectable bias, $E(\alpha)$, is approximately equal
3 to preselected mean error value, $E(\epsilon)$, and $E(\alpha)$ is approximately
4 zero.

1 64. (NEW) The computer program product of Claim 63, wherein
2 the predetermined characteristic further comprises a preselected
3 error variance value, σ_e^2 , substantially defined by the equation:

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$$\sigma_e^2 = \frac{2^{-2b} + 2^{-(2a-1)}}{12}$$

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1 65. (NEW) The computer program product of Claim 64, wherein
2 the rounding digit is selected from an alternating sequence of
3 digits in the pair of digits <0,1>.

1 66. (NEW) The computer program product of Claim 64, wherein
2 the rounding digit is selected from a pseudorandom sequence of
3 binary digits.

1 67. (NEW) A computer program product recorded on a computer
2 readable medium for rounding a first two's complement fixed point
3 datum, X , having an integer part of n bits, a fractional part of a
4 bits the integer part, and sign bit, s_i , to a second two's
5 complement fixed point datum, \hat{X} , having a fractional part of b bits
6 following the radix point, where a and b are representative of the
7 respective precisions of X and \hat{X} , and where $a > b$, comprising:
8

9 a. computer readable program code which evaluates the
10 fractional part of X and defining y as the most significant bit
(MSB) of the a bits;

11 b. computer readable program code which, if the first
12 bit following the radix point of X is equal to a "1" bit trailed by
13 ($a-1$) "0" bits, then defines \hat{X} substantially according to the
14 equation:

15
$$\hat{X} = n + s_i$$

16 and